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The Monitoring System for the Wind Power Generation Based on the Wireless Sensor Network

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Abstract

Aim at meeting the requirements of the wind power generation monitoring system, this thesis describes a system which builds up a wireless, real-time, multi-object remote monitoring system of the wind power generation. The hardware part of the monitoring system integrates MSP430F169 with CC2520 and CC2591, and the software part is implemented by TinyOS embedded operating system programming. The wireless remote monitoring system is depending on the WSN. There are many merits, which the wired network doesn't have, in the WSN. This design has established the communication between the monitoring terminal and the monitoring center.

Keywords: WSN;the monitoring system;the wind power generation; CC2520; CC2591;MSP430F169

1.Introduction

The development and using of the renewable energy source can effectively alleviate the predicament of the supply of energy and the change of climatic. The wind energy is regarded as new energy which has the broadest prospect of development and using. As the developing of the technology, the efficiency of economic and environment is more and more remarkable. The government of china takes seriously to the wind power generation. At present in china, most of the wind power generation's monitoring systems take the wired method as the foundation. And the majority systems which were already applied in the power station and the content of research is too unitary. But the wired method has many flaw. In this article has invented a set wind power generation observation system takes the wireless sensor networking as the foundation. During various nodes in this system selects the wireless communication method to carry on the data to lose, could effectively solve many difficult problems by the wired way in observation system [1].

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2.Overall System Design

2.1The choice of substation monitoring object

After investigation, we discover that the overall system needs to monitor dozens of kind of data. But so many data can divide into two kind, they are the analog signal and the digital signal. Therefore we only need to complete the analog signal and digital signal gathering and the data transmission in this data acquisition transmission system.

2.2.The structure of system and the function of component

The system involves three field, they are the wind field, the monitoring room and the middle region between the wind field and the monitoring and control room. The overall system is distributed in the above three different regions. The first is the parameter gathering node located at the wind field interior is responsible for gathering each kind of parameter. The second is located at between the wind field and the monitoring room it is the relaying node is responsible for the information relay transmission. The third is the monitoring room node, it is located at the wind field's "monitoring room" or neighbor, is responsible to relays the data which is the relaying node transmits to the control room node. This node will receive and compile data, send the data to the far-end control room through satellite, optical fiber, GSM or GPRS and so on. The overall composition of the system is shown in Fig1 [2].

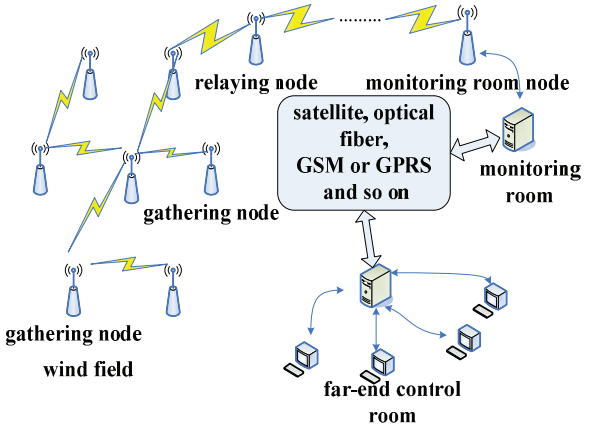

Figure 1. The overall composition of the system

2.3. Program of system networking

According to the requirements of the business data quantity, data transmission delay, reliability requirements, data privacy, network conditions. Far-end monitoring center establishes a fixed connection with the monitoring room. The monitoring terminal will login a wireless channel in the WSN when it comes to communicating and initiates a connection with the monitoring room node. And all nodes in the monitoring region, the relaying node and the monitoring node will compose a huge wireless network.
There are many operations in this system, these operations realize through the procedure.

3.The Hardware Design of the Monitoring System

3.1.The hardware design of node power

In the system, the request of radiofrequency component for the power is quite high. Here uses the low dropout regulator , it has many characteristics such as the low cost, small seal, few periphery component and low noise and so on. The typical LDO chip is TPS780330220 which produces by TI. So we use it to construct the power chip. Because its peripheral circuit is very simple, did not need to introduce it [2].

3.2.Microprocessor's choice

The microprocessor uses MSP430F169. Its power loss is very low, has rich the peripheral device in chip. Its peripheral circuit is very simple [3].

3.3.The hardware design of communication module

In order to increase the signal distance of each node as far as possible, in this design, take CC2520 as the base RF transceiver, and in its front take CC2591 as the power amplifier to increase the signal distance. The CC2520's peripheral circuit is simple as shown in Figure 2 [4].

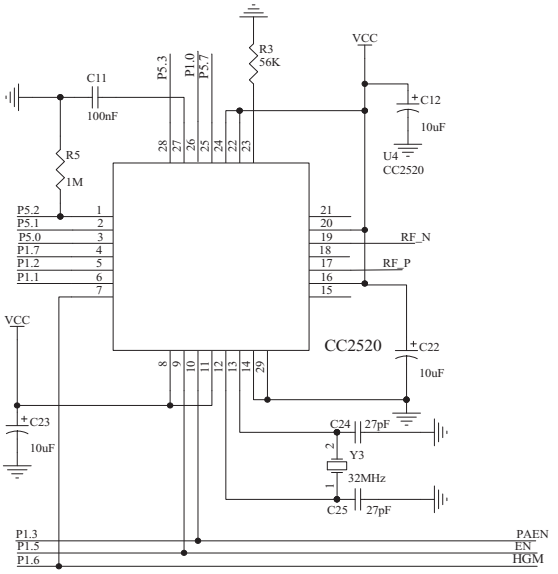

Figure 2. The CC2520's peripheral circuit

CC2591 is a range extender for 2.4-GHz low-power RF transceivers from TI. It increases the link budget by providing a power amplifier. Its application circuit is shown in Fig3 [5].

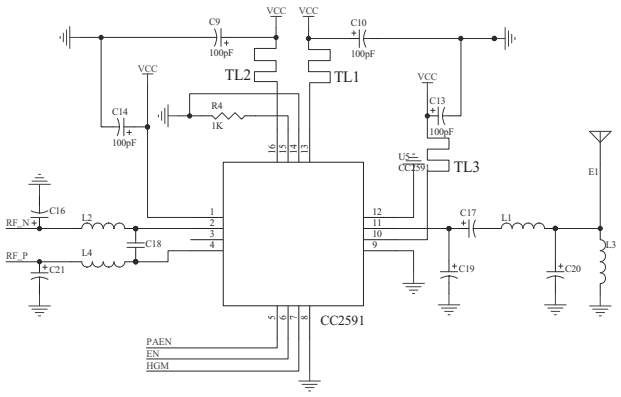

Figure 3. The CC2591's peripheral circuit

3.4.The hardware design of three nodes

- *The schematic diagram of nodes*

Three kinds of node's structures are very similar. The node's core is the MSP430 and RF transceiver. Only according to the node's different function, establishes the different functional module to different node. Gathering node's functional module is the signal conversion interface. The relaying node is composed to RF transceiver and processor. The monitoring room node's major functional modules are the RS232, the node status indicator circuit and the alarm circuit. The schematic diagram of three nodes is show in Fig4 [2].

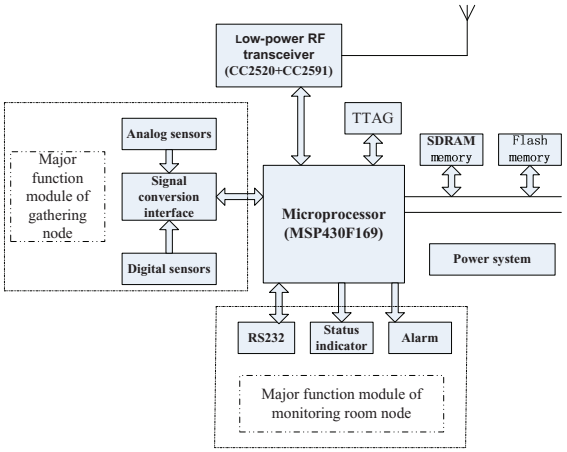

Figure 4. The schematic diagram of three nodes

- *The hardware design of gathering node*

The signal conversion interface includes the analog signal gathering circuit and the digital signal gathering circuit. They are responsible for transform the analog signal and digital signal, which transmit by the sensors, to suitable for receiving by microprocessor. They are show in Fig5 and Fig6 [6].

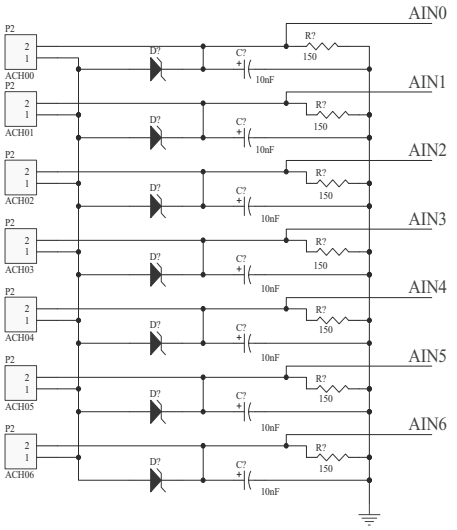

Figure 5. The analog signal gathering circuit

• *The hardware design of monitoring room node*

This node is responsible for receiving data and completing the communication between system and PC. The system and PC transmit the information through this node's RS232. According to system's request, this node increased the node status indicator circuit and the alarm circuit. RS232 uses SP3220 which product by TI, has low power loss, MSP430's I/O set the chip's pin (SHDN) at the high level cause the chip work at the low power loss condition. Because the MSP430 load capacity is very low, in this design the power the amplification circuit constitutes with LM386 to actuate the alarm [6].

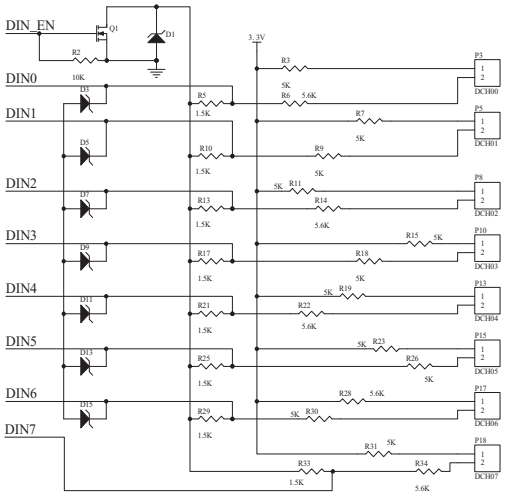

Figure 6. The digital signal gathering circuit

4.Software Design of This System

The system uses TinyOS embedded real-time operating system as the software operating platform, the design of software is implemented on TinyOS 2.0 Platform. The WSN embedded characteristic requests to disseminate new procedure code in the network [7].

4.1. The software design of the gathering node

The gathering node's master program mainly completes the data acquisition, processing and exchange and so on. The flowchart of main program is show in Fig7.

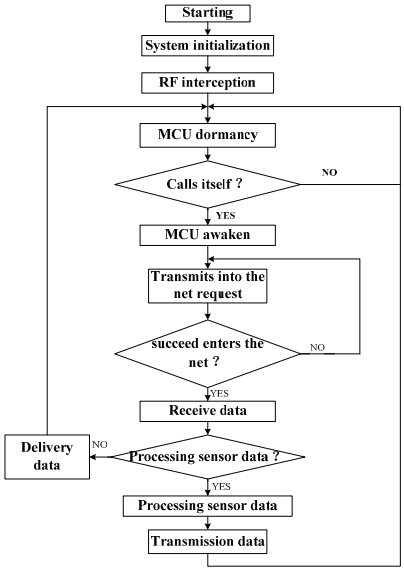

Figure 7. The gathering node's flowchart of main program

4.2.The software design of the relaying node

The relying node's master program is show in Fig8. It only completes to relay the data from one node to another, and relay the data to monitoring room in the end.

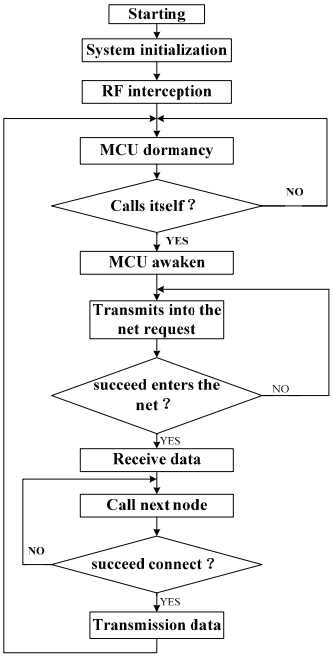

Figure 8. The relaying node's flowchart of main program

4.3.The software design of the monitoring room node

The relying node's master program is show in Fig9. It completes to control all of nodes in the system and to communicate with PC and so on .

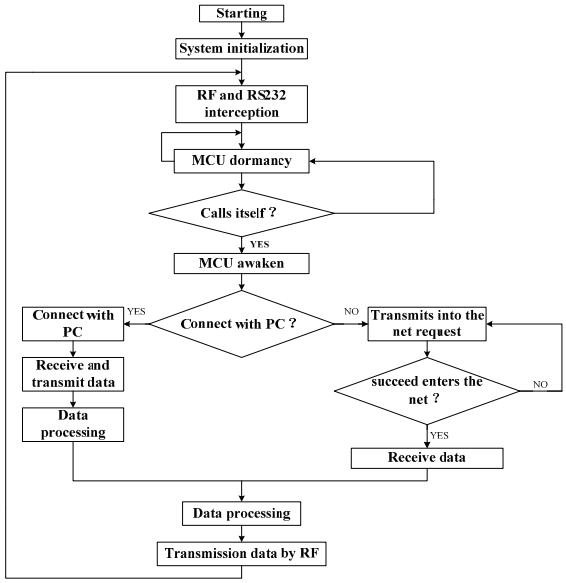

Figure 9. Monitoring room node's flowchart of main program

5.Conclusions

This remote wireless monitoring system implements real-time remote monitoring and management of wind power generation by using the WSN. System consists of three parts: the gathering node for field data collection and transmission; the relaying node for relay the data from one node to another; the monitoring room node for controlling the system and communicating with PC.

The hardware part of the monitoring system integrates MSP430F169 is one type of 16-bit ultra low power loss monolithic microcomputer with communication module CC2520+CC2591 which is TI's second generation ZigBee® /IEEE 802.15.4 RF transceiver for the 2.4 GHz unlicensed ISM band, and establishes nodes hardware system though some circuits such as external extended memory, signal conversion interface, RS232 and serial port; the software part is implemented by TinyOS embedded operating system programming. This design performs the functions of monitoring terminal which is expected, and establishes data communication between the monitoring terminal and the monitoring center.

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